'LIFE AND CHEMISTRY.'

TO THE EDITOR OF SCIENCE: The interesting address of Professor Charles Baskerville, entitled 'Life and Chemistry,' published in SCIENCE, Vol. XXI., No. 539, contains a statement which calls for review. He says that "Seed, one of the means of nature's reproduction, may remain years, centuries, in vaults, as within the Egyptian pyramids. When subjected to the proper conditions, they sprout and reproduce." What are the 'proper conditions' for the germination of these mummy seeds? DeCandolle, and others, experimented with seeds in many ways, and were unable to prove that they possessed such remarkable longevity as that referred to in Professor Baskerville's address. Their germinating experiments indicated that few seeds retained their 'vitality' after ten to fifteen years. They appeared to believe that thirty years was the limit of longevity in the most vigorous seeds.

Seeds collected from mummy cases, and reported to have germinated, are regarded by many botanists as 'salted.' This view regarding the short longevity of seeds is current in botanical literature. If that literature is incorrect it should be revised.

M. A. BRANNON.

SPECIAL ARTICLES.

THE IDEAS AND TERMS OF MODERN PHILOSOPHICAL ANATOMY.*

THE ideas of philosophical anatomy have been developed during three periods of human thought: First, the Greek, in which adaptation was clearly perceived as the central phenomenon of life, in its morphological and physiological expression. Second, the pre-Darwinian period, in which ideas of the environmental relations were developed especially by Bacon; and various forms of morphological, physiological and especially psychical adaptation were developed gradually through the studies of Buffon, Lamarck, Geoffroy, St. Hilaire and more especially Goethe; adaptations began to be distinguished broadly into *primary,* or those which had been of use in past time, and *secondary,* or those which were recent in origin and in full use at the present time. Even prior to these writers, however, Vesalius in his studies of human anatomy perceived the importance of this distinction. Philosophical anatomy really owes to Darwin himself the fundamental ideas which are involved in the terms primitive, retrogressive, progressive and dominant, and are now understood with perfect clearness. This is the third period of anatomy as established on evolution. Huxley in his brilliant essay of 1880 on 'The Laws of Evolution as Applied to the Mammalia' was the first to emphasize persistent primitive characters and modernized or adaptive characters, laying great stress on the importance of the former in questions of phylogeny. Among many other anatomical papers E. Ray Lankester's 'Degeneration, a Chapter in Darwinism,' brought out especially the significance of retrogressive changes.

Huxley was a master of logic, but even his keen vision failed to recognize the vast importance of the element of analogy, or similarity of function, in bringing about a similarity of structure in evolution independent of real similarity of kinship. This final phase broad extension of paleontology, and the demonstration over and over again in nature that similar forms have been produced independently either by parallelism from animals related in ancestry, or by convergence in animals unrelated in ancestry. To these processes and results of similar modeling Lankester has applied the fitting terms homoplasy and homoplastic.

In the table an attempt is made, for the first time to my knowledge, to bring together all these processes of change and to indicate their interrelations. There can be little disagreement as to the terms in columns I., II., III., but some surprise may be felt as to the broad inclusiveness of column IV. The justification for this column lies in the fact that in the analysis of any animal form the questions which each anatomist should put to himself as regards each character are: Is this a primi-

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THE IDEAS AND TERMS OF PHILOSOPHICAL ANATOMY.

COMPARISON.

I.	II.	III.	IV. As Regards Present Time.	V. As Regards Origin.
Life is the continuous adjustment of internal and external factors and processes. Adaptation is of the broadest character and relations, internal and external, including:		In every animal adaptations of the past, present and future mingle, and may be broadly distinguished into:	Animal and plant types, organs and functions are accordingly found in all grades of development and adaptiveness, with reference to past, present and future activity.	The results of adaptation in different animals and plants are also comparative, *i. e.*, similar, or dissimilar, according to the operation of similar internal (*i. e.*, hereditary) and environmental conditions.
Environmental or Bionomic, *i. e.*, in relation to physical and living surroundings, to geologic, geographic, physiographic, meteorologic, faunal and floral conditions or changes.	ADAPTATION AND ADAPTABILITY.	Primary or Primitive.	1. *Primitive.* 'Persistent primitive,' or arrested types, organs and structures which continue to be useful although perhaps of very great antiquity, resulting from the balanced or stationary, also 'progressive' and 'retrogressive' condition.	I. Homologous, *i. e.*, *Homogenous.*
Morphological or Anatomical, *i. e.*, structural, in organs, direct or correlated.		Secondary or Adaptive.	2. *Retrogressive.* Declining types, organs, habits and functions. Reduced, degenerating, partly functional, and functionless, passing through the stages of 'regressional,' 'vestigial,' 'variable,' 'atavistic,' or 'reversional' (according to certain percentages of occurrence) into 'recessive' (*i. e.*, very rarely reversional).	II. Analogous. *Parallel.* Analogous adaptations, *i. e.*, similar characters arising independently in *similar or related animals or organs*, causing a similar evolution, and resulting in parallelisms. 
Physiological or Functional, *i. e.*, in habits and uses of organs.			3. *Progressive.* Rising or developing types, habits, organs and functions. Rudimentary, prophetic or nascent organs and structures in the true sense of beginning, becoming sub-functional, then functional or fully useful.	*Convergent.* Similar adaptations arising independently in *dissimilar or unrelated animals or organs*, causing a secondary similarity or approximation of type, resulting in *convergence.* 
Psychical and Neurological in the brain, nervous system, and psychic life generally, imitations, instincts, intelligence.			4. *Dominant.* Organs, etc., attaining such importance as to overshadow all others, often leading to the extinction of the types through extreme specialization.	III. Non-Analogous. *Divergent.* Increasing specialization and differentiation resulting in 'divergence' or 'adaptive radiation.' 
		Transitional.	1. *Modifications.* Somatic changes, environmental, also use and disuse, in part germinal.	
			2. *Fluctuations.* Germinal, fluctuating changes of degree, continuous.	
			3. *Saltations.* Germinal, marked changes of kind, sports, mutations of De Vries, discontinuous variations.	
			4. *Rectigradations.* Continuous germinal changes in a single direction, mutations of Waagen.	
	The collective phenomena of fitness and the evolution of fitness as the essential and distinctive feature of life.	Fitness in time, *i. e.*, in past time, in the present, and tending toward fitness in the future.	Grades or degrees of fitness as determined in *individuals* by direct study or comparison, in the sciences of anatomy, comparative anatomy, paleontology, embryology, in ontogeny, fetal and larval life.	Fitness of certain groups or organs in comparison with *other groups* (*i. e.*, classes, orders, families, genera, species, varieties) as well as in comparison with organs and functions in other groups of animals.

tive or a secondary character? If primitive, is it in a balanced or stationary condition, or is it in process of change? Secondly, is this a retrogressive or a progressive character? Questions to be answered certainly only by the evidence afforded by ontogeny or paleontology, and in a comparatively limited number of cases by comparative anatomy. Further, it may be necessary to ask: Is this a dominant character, or one which has attained such importance in evolution as to crowd out and overshadow all others?

Anatomical analysis, however, does not stop here; we must constantly be on the lookout for transitional characters or characters in the very act of change. These transitional or evolutional characters appear at present to be of four kinds: first, *modifications,* or such as have been brought about during the life of the individual without necessarily being connected with germinal changes; second, *fluctuations,* or fluctuating variations, changes of degree or proportion which may be due either to somatic or to germinal causes, one of the most difficult problems in regard to fluctuations being to ascertain how much is germinal and how much is purely somatic; third, *saltations,* which are altogether germinal, or at least prenatal, in origin, including marked changes of kind, the 'sports' of Darwin and Galton, the 'discontinuous variations' of Bateson, and the 'mutations' of de Vries. Wide celebrity has been given to the word 'mutation' through the brilliant experiments and observations of de Vries, but the original significance of this term as employed by Waagen and Scott was a different one, and I think it probable that Waagen used it in the sense of determinate variation. Fourth, *rectigradation,* a new term with which I propose to characterize what in the year 1889 I described as 'definite variations'; it embraces changes which many writers have described as 'orthogenetic,' under the supposed law of direct change, usually in an adaptive direction, which is described as Orthogenesis; these probably are the 'mutations' of Waagen.

All the processes in column IV. are those which may be observed at the time or moment of observation in any organism, provided we have sufficient keenness of perception or sufficient knowledge to discriminate between them.

The elements of comparison given in column V., on the other hand, relate strictly to questions of origin, or to the past and the future, also to questions of comparison. The first broad distinction of comparison is between I., Homologous, and II., Analogous characters. In a strict interpretation homologous refers only to those elements which are 'homogeneous' (Lankester), or have an actual similarity of origin or ancestry. Under analogous characters there is a simple distinction to be drawn between the results of parallelism and of convergence, terms which I maintain should be used in a somewhat stricter sense than they have been hitherto. Looking to the past and future, we have III., the non-analogous characters and the broad phenomena of divergence. Appreciation of animal divergence, or of divergence in special structures and organs, naturally belongs to the evolutionary period of anatomical thought; a period beginning with the branching system of Lamarck and continued in the still clearer perception of divergence in the writings of Darwin. I have elsewhere proposed to employ the term 'adaptive radiation' for the general phenomenon of divergence as observed in a single group, distinguishing such a group in process of divergence as a 'radiation,' either a 'continental radiation' where diverging on a large scale, or a 'local radiation' where diverging in a more restricted environment.

It will be observed that while these ideas and terms are all evolutionary they are also *purely anatomical,* and restricted to anatomy. In a second communication the ideas and terms of modern evolution will be similarly treated.

HENRY F. OSBORN.

SOME PH.D. STATISTICS.

WE do not have to go very far back in the annals of higher education in the United States to discover a period when the percentage of instructors at a given university who had received the doctorate from the same institution, excluding foreign degrees, came perilously near the maximum. During the last ten or fifteen years, however, quite a change